ANATOMICAL ILLUSTRATION BEFORE VESALIUS[1]

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TWENTY-THREE FIGURES

The study of anatomical illustrations before Vesalius is not chiefly of antiquarian interest. It brings under consideration a momentous period of intellectual development when the scientific spirit was awakening and struggling for better expression. The examination of the human documents containing the early attempts at pictorial representation of the results of observation, have a peculiar interest for those who are still engaged in observing and recording results by the graphic method. Moreover, the consideration of these crude sketches reveals to us the conditions under which scientific men worked, the mental habit of the period, the educational practice in science and the degree to which accurate observation in anatomy prevailed. Nothing else shows more definitely the state of anatomical knowledge of the time, that which is covered and rendered ambiguous in the text stands exposed in the sketches—these graphic indices show the degree of fidelity to nature of the observer and his mental bias in the matter of interpretation.

[1] The notable interest of Professor Whitman in the historical phases of his science makes it appropriate that one of his students should offer in his memory a study of anatomical illustration before Vesalius—a study in the awakening of the scientific spirit.

Doctor Whitman was a pioneer in the United States in inaugurating university instruction in the history of comparative anatomy and of generation (see the Clark University Register for 1890). It is with pleasurable reminiscences that the writer acknowledges the influence of Dr. Whitman in the development of his mental interests. The friendly as well as the preceptorial relations with this leader of biological thought were a source of stimulus, especially as regards the philosophical outlook on nature, and the growth of a disposition to view current biological thought and attainment in the light of its historical development.

The pursuit of science from the historical standpoint has appealed only to a limited number, and there is needed at present a sympathetic recognition by scientific men, in general, that this affords a worthy field of research. This conception is being promoted by the relatively new movement in European universities, that has resulted in the appointment of professors of the history of medicine and natural science, to the establishment of periodicals devoted to researches in the same field and to the foundation in Leipzig of an Institut für Geschichte der Medizin. All this, and the growing disposition to provide a historical background for courses in biological study, is a sign that there is to be a widening of the field of biological research. It is to be hoped that the time is near when this line of study will be a recognized division of biological research, running parallel with other forms of biological investigation, and pursued as a research subject by examination of the original sources.

The attempts at pictorial representations of anatomy began before the invention of printing, as is shown in the pen, crayon and chalk drawings of anatomical subjects found in the medical manuscripts stored in the libraries at Berlin, Paris, Oxford, Munich and other places. A rich series of these manuscript anatomical sketches has been brought to light by Karl Sudhoff and his collaborators, and reproduced by photographic methods in the Studien zur Geschichte der Medizin and in the Archiv für Geschichte der Medizin. These resurrected manuscript sketches have thrown a flood of light on the sources of early anatomical illustrations. A genetic connection has been established between some of them and the earliest printed anatomical figures.

The question arises in connection with the early printed illustrations: Are these sketches crude representations of actual dissections, or are they based upon earlier traditional diagrams? They are in reality mixed as to the source. Many of the earliest printed anatomical figures that were thought to be original are traceable to manuscript sketches that were based upon reading of the anatomical descriptions of the Arabian and of the classical authors. Other printed illustrations based partly on observation show departures from the traditional schemes. There is,

however, even in the improved sketches, a mixture of observation and tradition, with a stronger inclination to preserve the traditional than to let go of it and depend on observation.

The date at which sketches of anatomical subjects were first used is uncertain. There is a tradition that Aristotle employed anatomical plates in his teaching, but no remnants of them are known. There are known, however, manuscript illustrations of anatomy dating back to the twelfth century, and furthermore, some of the manuscript sketches of the early part of the fourteenth century have a recognized genetic connection with the earliest printed illustrations of anatomy. For example, Sudhoff has recently published copies of the diagrams used by De Mondeville, about 1304, to illustrate his lectures at Montpellier, and the connection between these pictures and those published by Peyligk in 1499, and by Hundt in 1501 is undoubted. There are other known correlations between manuscript sketches and early printed figures that will be mentioned later in connection with a consideration of the printed sketches.

The earliest printed illustrations of anatomy occur in the Fasciculus Medicinæ of Ketham of 1491, and, from that time to the publication of the Fabrica of Vesalius in 1543, there are about one hundred different anatomical cuts. Some of these pictures are duplicated in different treatises so that the enumeration of figures in the different printed books would exceed this number. This statement does not include the seven hundred to eight hundred anatomical sketches of Leonardo da Vinci, none of which were published until much later. In addition to the printed books of the period there were anatomical plates printed and sold separately. To this latter group belong the figure of the skeleton by Richard Helain, printed in Nürnberg in 1493, and its modification, by Grüninger of 1497, the anatomical plates of John Schott of 1517, the plates of Vesalius of 1538, etc.

The pictures of this period are little known to anatomists, accordingly it is the printed illustrations of anatomy from 1491 to 1543 that are to be brought under consideration in this paper. The writer has had for personal examination the printed books containing the pictures referred to with one or two exceptions

that will be noted below. The subject of manuscript illustrations is not attempted, since very few of these have been available, and the references to manuscript sketches are drawn chiefly from the publications of Sudhoff.

In reviewing the old anatomical treatises, points of bibliographical interest emerge, and comparison of the texts brings out some features of interest to scholars. No attempt has been made however to embrace bibliographical notes and textual comparison. The boundaries of the paper are limited to a consideration of the character and quality of the earliest illustrations of anatomy with the further aim to determine to what extent these are based on observation, and to add some comments on the conditions or the time as they affected the development of observation in science. The pictures are not comprehensive enough in their range to show all the anatomy of the period, but they are significant in showing the spirit of the time, the dependence on descriptions and the lack of a positive anatomy based on observation.

Sources. The printed books published before 1543, that contain anatomical figures are medical treatises, anatomical texts and surgeries. I have had for examination, chiefly in the Surgeon General's Library at Washington and the John Crearer Library at Chicago, the primary sources named below. The books are designated by date and abbreviated title only, since the full titles are often long and cumbersome.

I have examined thirteen copies of the anatomical treatise of Mundinus, Anatome omnium humani corporis interiorum membrorum. Of these, seven were published separately and six were incorporated with other writings in the Fasciculus Medicine of Ketham. The collection embraced: two copies of the Melerstat edition of Mundinus, published in Leipzig about 1495, 39 leaves, 4°, with one illustration; and one copy each of the editions of G. Lincium, Venice, 1494, 22 leaves, no illustrations; F. Picium, Freiburg, 1507, 23 leaves, no illustrations; J. Adelphus, Strassburg, 1513, 40 leaves, figure of the zodiacal signs as related to regions of the body and a rough sketch of the heart; the large annotated edition of Berengarius, Bologna, 1521, 528 leaves (1056 pages), 21 woodcuts and the extensively illustrated edition

of J. Dryander, Marburg, 1541, 70 leaves, 45 woodcuts, one repeated, and two on one plate. These books are all of quarto size. In addition I have had six copies of the Incipit Anatomia Mundini in the editions of Ketham mentioned below.

Six editions of Ketham's Fasciculus Medicine (or Medicinæ) came under observation, all of folio size; Venice, 1495, Latin edition; Venice, 1500, Italian; Venice, 1500, Latin; Milan, 1509, Italian; Venice, 1522, Latin; Venice, 1522, Italian. All these contain woodcuts to be mentioned below.

The plate of the skeleton by Richard Helain, Paris and Nürnberg, 1493, 53 cm. high, from the library of Dr. Mortimer Frank of Chicago.

J. Peyligk, Philosophie Naturalis Compendium, containing the Compendiosa capitis physici declaratio, which is the illustrated part, Leipzig, 1499, folio, frontispiece and thirteen separate anatomical illustrations in the text.

Magnus Hundt, Antropologium de hominis dignitate natura et proprietatibus, Leipzig, 1501, 4°, 120 leaves, 19 figures, one being repeated. Two copies of this rare book came under observation, one in the Surgeon General's library and the other in the library of Dr. Mortimer Frank of Chicago.

Phryesen (Fries, Frisen, etc.), Spiegel der Artzney, three copies, the Strassburg edition of 1519, folio, Dutch, 4 figures; Strassburg, 1529, German, 141 leaves, one picture in addition to the illuminated title page, and the same, Strassburg, 1532.

Berengarius (Carpus), his Commentaries on Mundinus (mentioned above) Bologna, 1521, 4°, 528 leaves and 21 woodcuts. Three editions of his Isogogæ Breves: Bologna, 1523, 4°, 80 leaves, 23 figures; a small pocket edition, 1530, 132 leaves, with 24 very crude, small woodcuts copied from the edition of 1523; Venice, 1535, 4°, 63 leaves, 19 cuts.

Petrus d'Abano, Conciliator differentiarum philosophorum, 1526, containing the first printed pictures of the abdominal muscles copied from the edition of 1496.

Leonardo da Vinci, I Manoscritti di Leonardo da Vinci della Reale Biblioteca di Windsor, etc., Paris, 1898, 1901, etc.; ten of the twenty-four volumes contain anatomical sketches and

notes, 223 plates and upwards of 750 figures, with an introduction by Duval. These anatomical illustrations, executed about 1510, are in all particulars the most notable contribution to anatomy before Vesalius.

J. Dryander, Anatomia Mundini, and other old writers, Marburg, 1541, 70 leaves and 44 illustrations.

W. H. Ryff, Anotomi (very long title), 1541, woodcuts.

For collateral reading the treatises of Choulant, Chievitz, Hopf, Hyrtl, Roth, Pagel, Sudhoff, Töply, Weindler and Wieger have been of especial service. In Wieger are found photographic reproductions of visceral dissections from Reisch's Margarita philosophica, 1503 and 1504, forming a link in the development of anatomical sketches. I am greatly indebted to the contributions of Sudhoff for general enlightenment, for knowledge of the manuscript sources and for an illustrated account of Brunschwig's Anatomy in his Chirurgie, 1497.

Mundinus. (Mondino, etc.; the Romanized form of his name is used here because his book was chiefly printed in Latin.) The anatomy of Mundinus (Anatome omnium humani corporis interiorum membrorum, De omnibus humani corporis interioribus membris anatomia, Incipit Anathomia Mundini, etc.), although not the first treatise on anatomy to be illustrated, is the natural starting point for a consideration of pre-Vesalian anatomy. Appearing, in manuscript, in 1316, it was the first professional treatise on anatomy after more than eleven centuries of Galen. On account of the extensive use in medical schools it forms the genetic link between the ancient anatomy and that of the renaissance period. It was the forerunner of the anatomical treatises that appeared before the epoch-making book of Vesalius.

Mundinus, on account of the influence of his teaching and of his treatise, looms large in the background of historical anatomy. He helped to overcome the opposition to dissection and he is usually credited with having brought the practice into general recognition. Although he was a pioneer in the restoration of anatomy, his way had been prepared by others. De Mondeville as early as 1304 had been illustrating his lectures on anatomy at Montpellier; the Senate of Venice had decreed in 1308 that a

body should be dissected annually; William of Salicit, Richardus and others had dissected before Mundinus.

The purpose of his book was to simplify the teaching of anatomy and it was designed primarily for his students. (As he says: "proposui meis scholaribus in Medicina quoddam opus componere.") It was so highly esteemed that it had a general use for upwards of two centuries and often was used as an introduction to Galen or in connection with his anatomical writings. It came to be prescribed by legislation as the required textbook of anatomy in Italy. Before the invention of printing it was copied and extensively circulated among medical students. Mundinus was a great favorite with the students who came under his instruction. He seems to have been a man of engaging personality gifted with powers of clear exposition. His book is well arranged and terse in description. Although he states that prior to its composition he had dissected three human bodies, it is too much to say that it was an original treatise based on personal observation. He merely brings into systematic form the teachings of Galen with some modifications of his own. Roth and others have pointed out that in his compilation he did not make use of a pure text of Galen in the Greek, but, on the contrary, employed impure Latin and Arabic translations. He does not succeed in overcoming the influence of tradition and of dialectic compilation. With Galen he enumerates five lobes in the liver and perpetuates other errors that observation on the human body should have corrected. His book is also burdened with the terminology of the foreign texts; the stomach, for illustration, is designated the myrach, the peritoneum as the cyphach (siphac), the omentum as zirbus, the mesentery as eurachus, etc., etc. The key to the influence of the book of Mundinus is not its originality but its wide circulation; it is conspicuously lacking in evidences of independent observation.

The book was first printed in small folio form in Padua, in 1478, and, between that date and 1580, when the last edition was published, not less than twenty-five editions are known. These are usually annotated and commonly in quarto form. The thirteen editions of Mundinus examined, excepting those in Ketam,

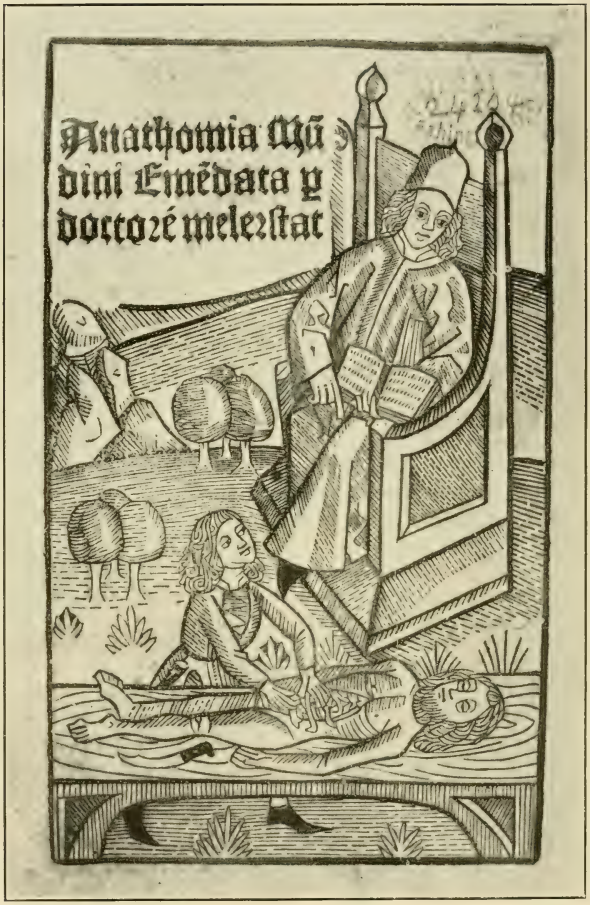

Fig. 1 From the Melerstat edition of Mundinus, Leipzig, 1493

vary from an edition of 22 quarto leaves to the extensive edition of Berengarius, of 1521, containing 40 commentaries and 586 leaves. The 21 illustrations in the last mentioned will be considered under Berengarius.

The only edition to be mentioned at present is that of Dr. Melerstat, printed in Leipzig about 1493-95. The book was published without date or indication of place. The copy in the Surgeon General's library at Washington has a note saying that it was published, probably in Leipzig about 1493. It has 39 leaves, including the title page, with a letterpress of $3\frac{5}{8}$ x 6 inches. This was the first edition to be printed with a woodcut which is shown reduced in fig. 1. The original is $3\frac{3}{8}$ x $8\frac{5}{8}$ inches. It represents a teacher of anatomy seated and reading from a textbook, while, in front, his demonstrator is engaged with a visceral dissection. The sketch of the viscera is highly diagrammatic. On the table is seen the large curved knife like that exhibited in the pictures of surgical instruments of the period. This picture shows the method of teaching anatomy at that time. Often the reading was done without any subject before the hearers, at other times dogs and other animals were used for demonstration, and, on rare occasions, a human body was dissected in public anatomies. This picture is a type of many others found both in manuscripts and in early printed books. Sometimes in these pictures students are shown grouped around the dissecting table, but the teacher is always seated and reading from a text. The academic dress is a feature of them all and affords an index to the costume worn by teachers and students at different schools and at different periods of time. For several similar pictures see Choulant, Chievitz, etc.

Ketham. (Johannis de Ketaz, etc.) The Fasciculus Medicine (also Medicinæ) of J. de Ketham is believed to be the first printed medical treatise to be illustrated. The first edition printed in Venice in 1491 contained six woodcuts and the subsequent editions contain usually nine or ten. Prepared under various editors, there are several editions but they are similar as to text and illustrations. The book is of folio size and is a collection of medical writings embracing sections on the means of recognizing

diseases by the various colors of the urine; the practice of venesection and blood letting; comments on surgery; the figure of female anatomy, showing a foetus in the uterus; advice regarding diseases and, in 1493 and thereafter, the anatomy of Mundinus.

Only two of the illustrations can be classed as anatomical, that showing the location of the viscera in the female (fig. 2), and preparation for opening the body cavity, first introduced in 1493, in connection with the Incipit Anathomia Mundini. The other illustrations show: the circle of 21 urine glasses, with circles indicating the four temperaments; the signs of the zodiac as related to parts of the body, as in the figures in the old almanacs; the points on the body for blood letting; a sick man on a couch; the wounded man, showing cuts, impact of clubs, etc. The drawings were made by Petrus de Montagnana.

Fig. 2, reduced from the edition of 1491, gives a fair conception of the quality of the pictures. This figure is borrowed from Wieger, since I have not had the edition of 1491 for examination, but have examined the corresponding figure in various editions beginning with that of 1495. The sketch shows in outline the position of the viscera; the uterus is represented as opened and containing a foetus. In 1493 the drawing of the female figure was modified by observations, and after that date the illustration bears the inscription 'Tratta dal Natura.'

A very interesting connection between the printed copies of this book and its manuscript sources has been brought to light by Sudhoff. He found about 1907, in the Bibliothèque Nationale at Paris, a neatly written Latin manuscript of quarto size, and 54 leaves, which belongs to about the year 1400. In this manuscript is a complete series of the Ketham pictures of 1491, and much of the Ketham text. After folio 45 in this manuscript is an anonymous treatise that agrees substantially with the Fasciculus Medicine of 1491. The text and figures of the Paris manuscript are not assembled as in the Ketham of 1491, but the text is in places identical, and the printed figures are evidently copies of the manuscript sketches. The way in which this collection of writings came to bear the name of Ketham is a matter of conjecture. Sudhoff thinks likely that there was a Johannis

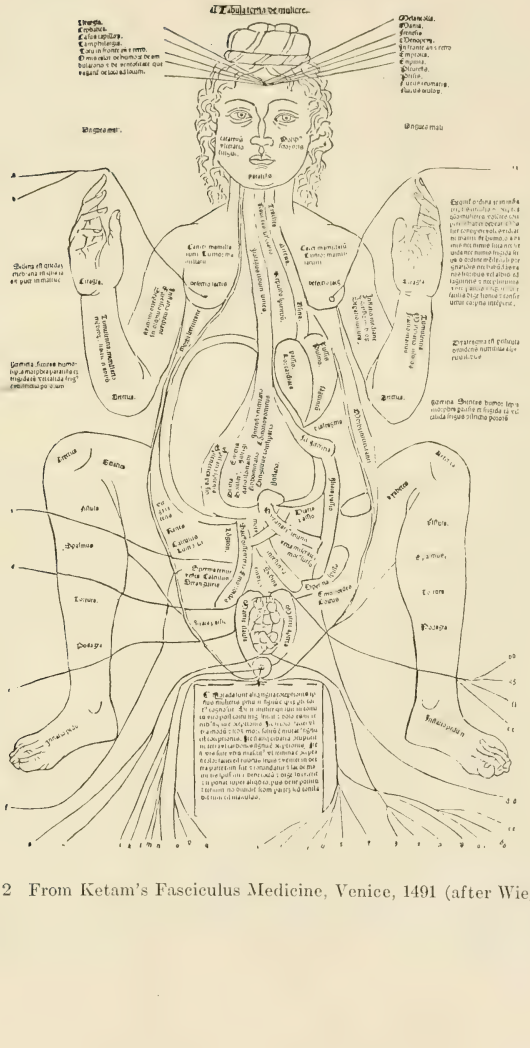

Fig. 2 From Ketam's Fasciculus Medicine, Venice, 1491 (after Wieger)

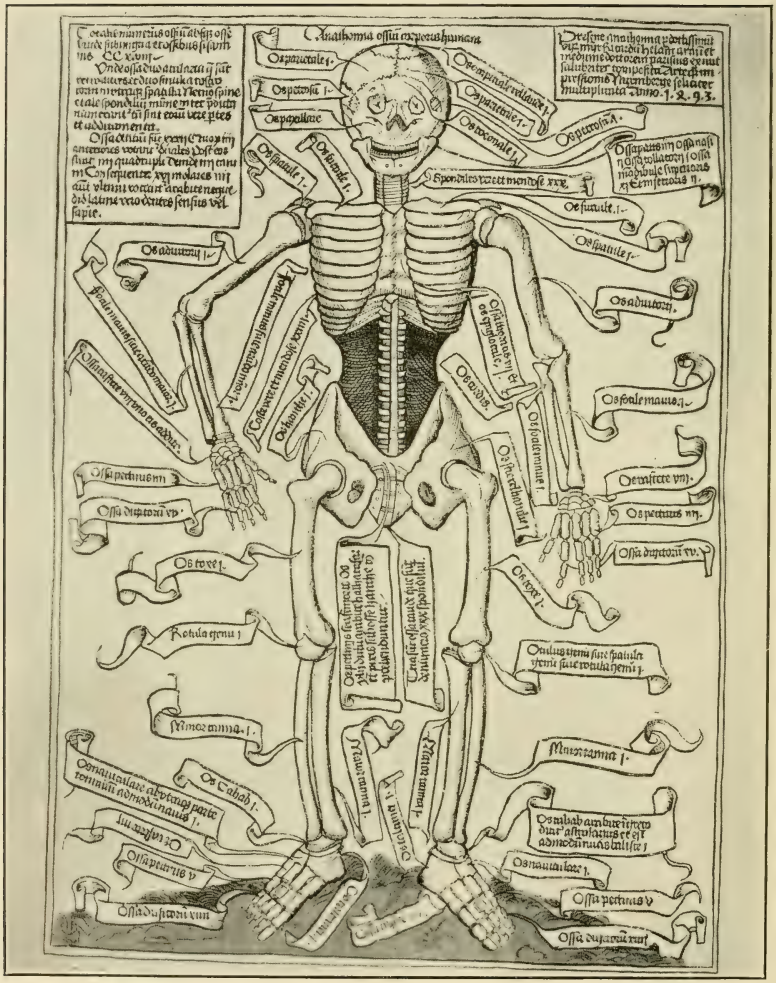

Fig. 3 The skeleton of R. Helain, Nürnberg, 1493 (after Wieger)

de Ketham, who, about a century before 1491, assembled the drawings and text, and, that when printed for the first time they bore his name, but of this we have no certain knowledge. This whole collection is probably derived from earlier manuscript sources in French, German and Italian.

Prior to the publication of Ketham, there was printed in 1485, in De proprietatibus rerum of Barthalomaeus Anglicus, a woodcut of some anatomical interest. Standing in front of a walled garden is the figure of a man with the abdominal cavity opened and a very diagrammatic representation of the viscera. Within the garden the figure of Eve is appearing before the Lord from the side of the sleeping Adam.

R. Helain. Anatomical figures on separate plates were published as early as 1493, the first one to appear being a representation of the skeleton. It is probable that plates of this kind were exposed in barber shops and bath establishemnts, and that they were also purchased by medical practitioners and by the curious of the general public. A cut of the earliest known picture of this kind is shown in fig. 3, which is copied from Wieger, although I have since seen a copy of the original in the library of Dr. Mortimer Frank of Chicago. It is attributed to a Paris physician, Richard Helain, and was printed in Nürnberg in 1493. Whether or not it was also printed in Paris is not known. The original plate was 53 cm. high. It seems to have been drawn from a partly dried specimen and the drawing is in many particulars fantastic. Among the curious features are, the dark abdominal portion, the expanded pelvis, the divided lower jaw and numerous teeth (17 on the lower jaw), the bones of the feet and the 'os laude' of the skull. This 'os laude' or 'os capitale relaude' is an apochryphal bone, and its designation will puzzle those acquainted with classical Latin not a little. We might expect it to be os laudis but in the corrupted Latin of the period the termination *e* is commonly used for *ae* and we conclude that it is 'os laudae.'

This anatomical plate is referred to by Hyrtl, Wieger, and others as the work of Ricardus Hela. There is probably a mistake in the name, since Sudhoff, by a careful search of the records of the Paris physicians of this time, was not able to find the name of

Hela, but instead found that of Richard Helain. The plate should probably be attributed to him. This picture formed the basis for a modification by the publisher Grüninger in 1496–97 (fig. 4) which was printed in Brunschwig's Chirurgie, in 1497, and in various other texts. The picture (fig. 4) is however taken from Phryesen's Spiegel der Artzney, 1519.

The earlier manuscripts show a considerable number of sketches of skeletons, some of which resemble the drawing of Helain. (See Sudhoff, Studien zur Geschichte der Medizin, Hft. 4.)

Petrus d'Abano. In the Conciliator differentiarum philosophorum of Petrus d'Abano there appeared in 1496 the first printed illustration of the abdominal muscles. This is shown, considerably reduced, in fig. 5, which is taken from a reproduction of the woodcut by Sudhoff in its original dimensions ($5\frac{5}{8}$ x $6\frac{7}{8}$ inches). I have had for examination the 1526 edition of the Conciliator in which the same figure occurs, slightly modified and reduced in size. In that edition, in the 199th differentia, on page 231, is a description of the eight abdominal muscles. The picture is evidently made with the help of a dissection. There were earlier editions of the Conciliator in 1472, 1476, 1483 and 1491, but there is no picture in any of these; the first illustrations occur in the third Venetian edition of 1496. There is also a manuscript edition of the Conciliator near the beginning of the 14th century that speaks of eight abdominal muscles from Greek and Arabian sources.

Sudhoff, in pointing out that the figure of 1496 was based on a dissection, locates that dissection in Bologna. He found a copy of Mundinus with a marginal pen drawing of these muscles by a student, dated Bologna, 1494.

Brunschwig. In the interval between 1496 and the appearance of Peyligk's illustrated treatise came the publication of Brunschwig's Chirurgie in 1497. A few pages of this is devoted to anatomy, and in it we find a picture of the Grüninger skeleton (fig. 4), which was a modification of the Helain skeleton of 1493, and also a picture of the wounded man showing visceral anatomy. This picture is one of the series showing the development of illus-

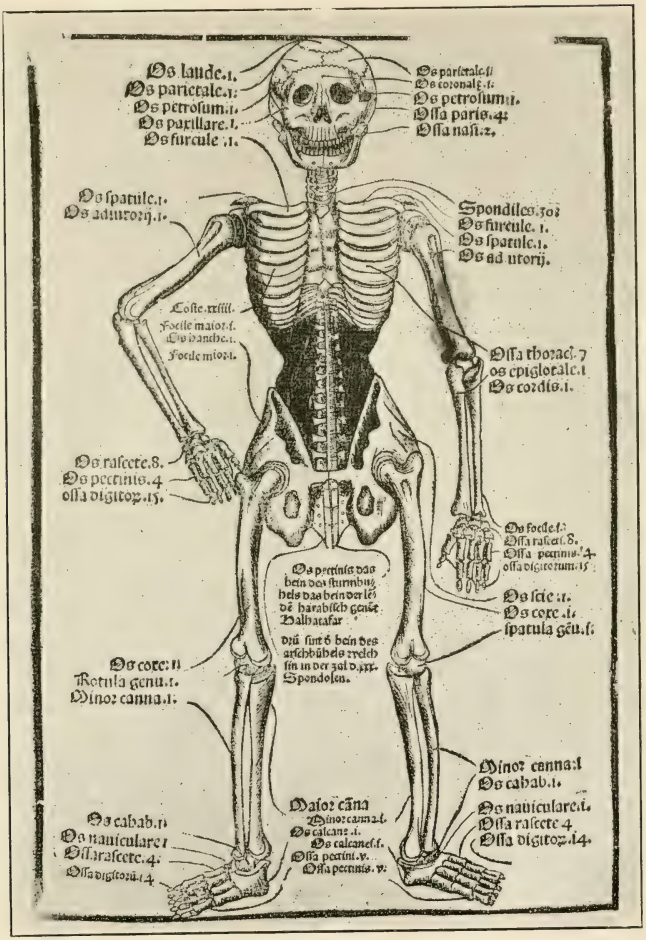

Fig. 4 The Grüninger modification (1497) of the skeleton of Helain. Printed in Brunschwig's Chirurgie, 1497, and in other later texts. This cut from Phryesen's Spiegel der Artzney, 1519

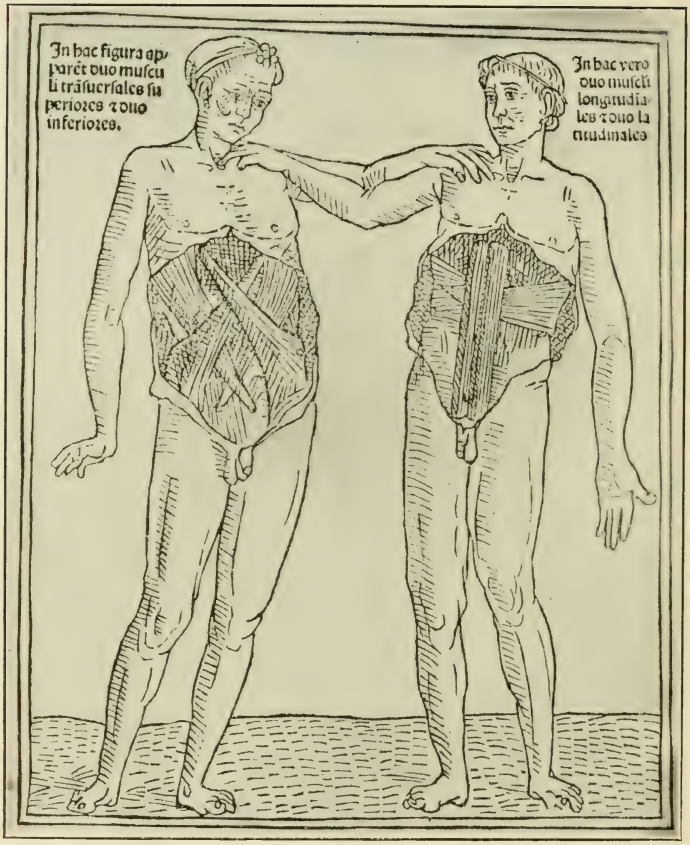

Fig. 5 First printed sketch of the abdominal muscles, from the Conciliator Differentiarum of 1496 (after Sudhoff)

trations of internal anatomy. It is reproduced by Sudhoff in the Archiv für Geschichte der Medizin, Bd. 1.

Peyligk. In 1499 was published the Philosophie Naturalis of Johannes Peyligk which contains ten figures of separate organs of the body besides one large figure showing internal anatomy of head, thorax and abdomen. Peyligk's book is the compilation of a jurist of Leipzig. It is a fine folio of 96 leaves, $8\frac{1}{2}$ x $11\frac{3}{4}$ inches, with the letterpress $4\frac{3}{4}$ x 8 inches. The last twelve pages are embraced under the title Compendiosa capitis physici declaratio principalium humani corporis, etc., and it is this part alone that contains the anatomical illustrations. The frontispiece, which is printed on the reverse of the last page of the Philosophie Naturalis, is shown reduced in fig. 6, the original being $3\frac{1}{2}$ x $7\frac{5}{8}$ inches. In this figure we see the three cavities (venters) of the body indicated; the upper (supremis), containing the animal members; the middle (medius), containing spiritual members and the lower (inferioris), containing the natural members. The head shows only the ventricles of the brain as conceived of at that time. The thoracic cavity has a diagram of the lungs, the heart, the trachea and the œsophagus. Below the diaphragm, which is indicated as an oblique line passing across the trunk, there is represented the stomach, the spleen, the intestines and the liver with two blood-vessels. The liver is represented with five lobes according to Galenic tradition, and the gall-bladder is shown as a pear-shaped vesicle on the liver. In addition to this large diagram of the organs *in situ*, the text is embellished with sketches of the separate organs. Fig. 7 shows a picture of the page containing the figure of the stomach, œsophagus and intestines. Fig. 8 shows the separate illustration of the heart; the manuscript notes in this copy are also to be seen. All these figures, manifestly, are diagrams and not sketches from nature. Since they are the earliest printed illustrations of separate organs, it is an interesting matter to locate their source. Are they purely fanciful sketches based on descriptions of earlier writers?

The source of Peyligk's figures remained for a long time undetermined, and the assumption was generally made that they were schematic mental pictures, derived from reading the anatomical

descriptions of Arabian and classical writers, and transferred to paper. The sketches are certainly schematic and show the influence of tradition but they were not produced by Peyligk. The speculation of Stockton-Hough that they came from an illustrated Mundinus of 1498 is unfounded. There is no known illustrated Mundinus of 1498 and the suggestion is probably due to a confusion of the Mundinus text in Ketham's Fasciculus of 1495. Several of the sketches are now traceable to the diagrams of Henri de Mondeville, and used by him about 1304 in illustrating his anatomical lectures at Montpellier. Pagel made known in 1889 that de Mondeville had employed sketches and, in 1890, Nicaise reproduced the miniature sketches of entire figures showing internal anatomy. He says that de Mondeville also made use of sketches of separate organs of which all trace had been lost. These separate sketches have now been unearthed and were published in 1908 by Weindler, and, in a separate article, by Sudhoff. Those reproduced by Sudhoff embrace eighteen manuscript figures, nos. 1 to 7 found in the Royal Library at Berlin and nos. 8 to 18 in the Royal Library at Erfurt. The resemblance of some of the figures of Peyligk to these manuscript sketches of de Mondeville, leaves room for no reasonable doubt that the latter were the sources from which the Peyligk figures were drawn. It is uncertain how the pictures of de Mondeville originated. Sudhoff suggests that possibly de Mondeville began illustrating his earliest lectures at Montpellier by making diagrams of traditional anatomical sketches. Of this we have no certain knowledge, but we have, at any rate, the sketches of separate organs of de Mondeville to add to his miniature pictures of entire anatomical figures that were previously known.

Hundt. The next printed anatomical illustrations to come under notice are those of Magnus Hundt, a Leipzig anatomist. His Antropologium de hominis dignitate, etc., published in 1501, is a rare quarto of 120 leaves, with a letter-press $3\frac{1}{4}$ x $5\frac{3}{4}$ inches. It contains nineteen illustrations, one of which is printed twice. The sketch of the viscera *in situ* is shown in fig. 9. There is another large figure in the book (the one that is repeated) showing the ventricles and the general location of physiological function

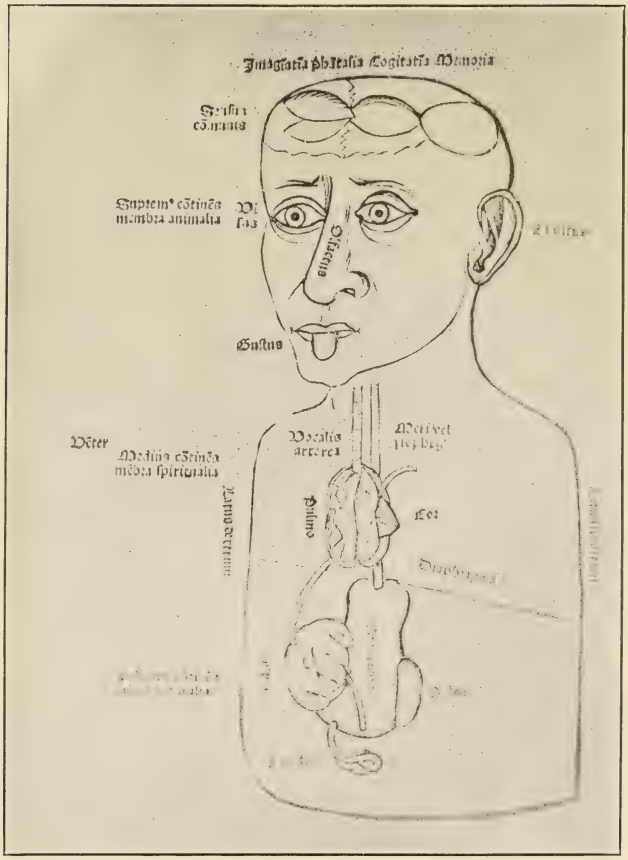

Fig. 6 From Peyligk's Compendiosa, 1499

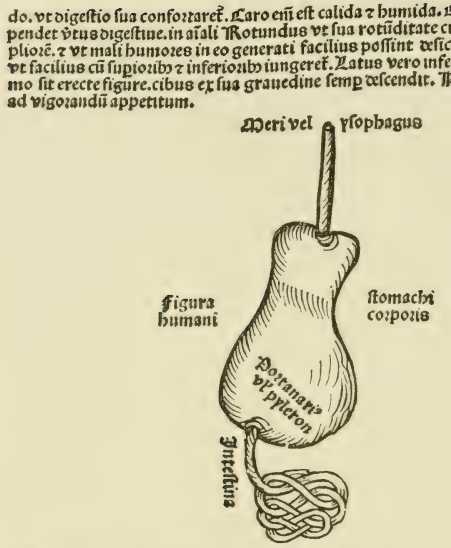

Fig. 7 Part of page from Peyligk, showing sketch of stomach and intestines, 1499

of the brain. The original of fig. 9 is $3\frac{1}{8}$ x $5\frac{1}{4}$ inches. It is in some particulars more crude than the corresponding figure of Peyligk. In the thoracic cavity one sees the undivided lung, the heart, the trachea and the œsophagus. In the abdominal cavity is the large many-lobed liver with the gall bladder on its surface, the pouch-like stomach, the spleen, the loops of the intestine, and, pushed to one side, the kidneys, the bladder and the testes. The blood vessel connected with the liver is the 'vena chilis' and the blood vessels to the kidneys are the 'venæ emul-

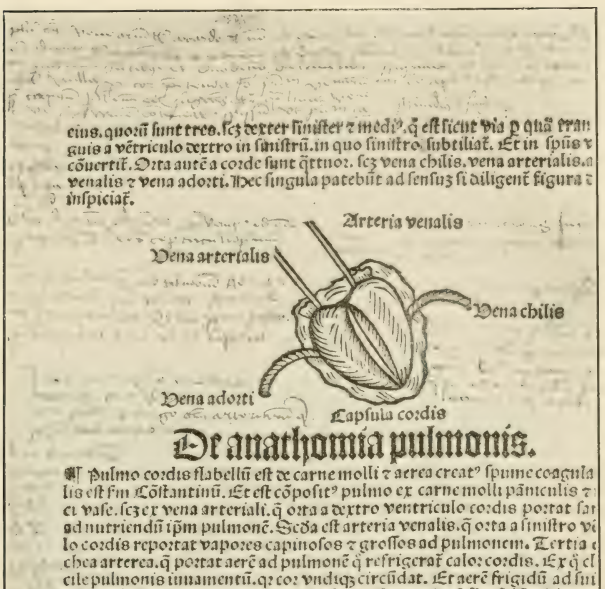

Fig. 8 Sketch of the heart from Peyligk, 1499

gentes.' In the figure that I have photographed the iris of the eye is black, while in that reproduced by Sudhoff from the copy in the Leipzig library the iris of the right eye is indicated by a white circle.

The book is provided with text-figures of separate organs copied from Peyligk's treatise. The figures, however, are not printed from the same blocks; they are nearly identical but careful inspection will show slight differences in the lines. Fig. 10 shows the sketch of the liver with a part of the text. It is the same as the corresponding figure in Peyligk but is not quite so carefully engraved.

Gregor Reisch. In the 1504 edition of Reisch's Margarita Philosophica there is an illustration (see fig. 11) showing new details in internal anatomy of the thorax and abdomen. Although the anatomy is very crude it is an improvement over the corresponding figures of Peyligk and Hundt. The kidneys and bladder are represented in a more nearly normal position. The lungs are

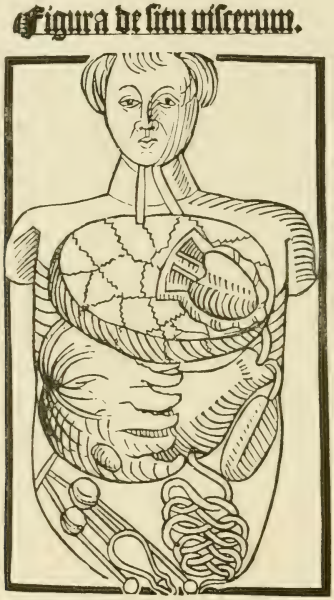

Fig. 9 Visceral anatomy from Hundt's Antropologium, 1501

divided into lobes; the liver, stomach, spleen and intestines are still very untrue to nature. The nomenclature of the period is shown in the names attached to the organs, the lung, 'pulmo,' the heart, 'cor,' the liver, 'epax,' the kidney, 'ren,' the bladder, 'vesica,' etc. In 1503 a similar picture had appeared in the edition of the Margarita Philosophica from the printing house of

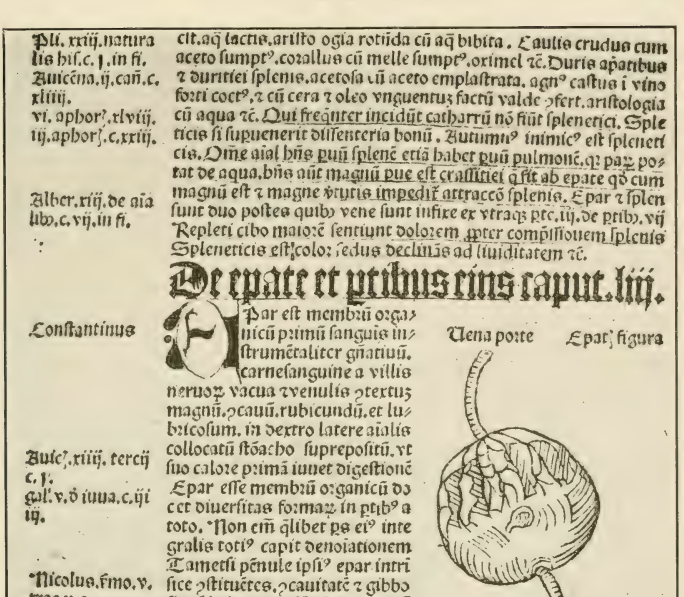

Fig. 10 Part of page from Hundt's Antropologium, 1501

John Schott. In this earlier picture the ureters are not shown, and the intestine is represented as connected with the bladder. I am indebted to Wieger's treatise for the sketch of 1504, that appeared in the Margarita Philosophica published by Grieninger. This figure was reproduced in other texts and the original of this cut (fig. 11) is in Brunschwig's Destillirbuch.

Leonardo da Vinci. With Da Vinci we come to the one man who, before Vesalius, showed independence in observation and

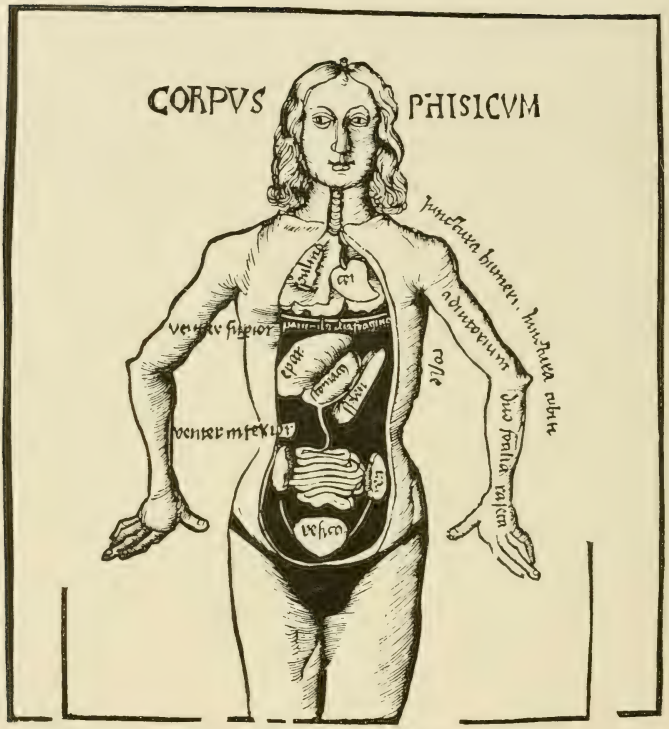

Fig. 11 Visceral anatomy from Reisch's Margarita Philosophica, 1504. This cut from Brunschwig's Destillirbuch, 1512 (after Wieger)

notable fidelity to nature in his sketches. Although the larger number of his anatomical drawings were made about 1510 they were not fully published until 1898 and 1901. They bear internal evidence of having been made from actual dissections. It is well known that he became associated with Della Torre who projected a treatise on anatomy for which Leonardo was to supply the drawings. Nevertheless, Da Vinci had studied anatomy independently before his association with Della Torre, and he contin-

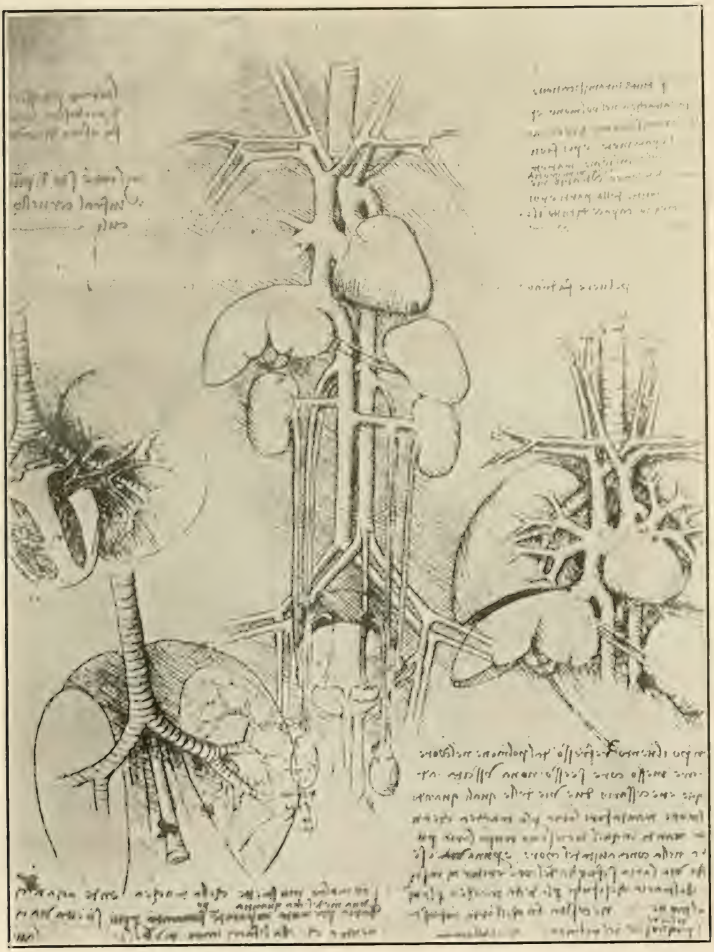

Fig. 12 Anatomical sketches from I Manoscritti di Leonardo da Vinci, 1510 (after the Paris *facsimile* edition)

ued to make dissections and anatomical sketches after the death of the latter in 1506. We may assume that his method was improved by intimate collaboration with a professional anatomist, but we must recognize that this extraordinary man was a master unto himself. The association with Della Torre was not merely that of an artist working under an anatomist who exposed the parts and required sketches made under his direction. It was

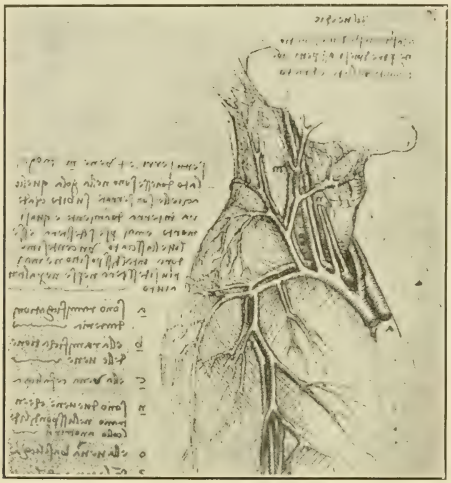

Fig. 13 Anatomical sketch by Leonardo da Vinci, 1510

rather the coöperation of two anatomists, one of whom was gifted with great powers of artistic delineation. Antonio de Beatis had it from Leonardo's own lips, about 1510, that he had dissected not less than thirty human bodies, both male and female.

Leonardo projected a comprehensive work on anatomy of which he speaks in his History of Painting, and also in his manuscript notes. The notes and drawings bear testimony that this treatise was not designed merely for artists but was to be, as well, a work for medical students and for the professional anatomist.

The working drawings and notes for this projected work are preserved as a part of the manuscript collection in the Royal Library at Windsor Castle. They were published in Paris in 1898 as Foglio A of Leonardo's Manoscritti. This sumptuous volume

Fig. 14 Anatomical sketch by Leonardo da Vinci, 1510

contains 245 anatomical sketches, reproduced as fac-similes both as regards the sketches and the paper upon which they are drawn. The notes are translated into French. His other anatomical sketches, also in the library at Windsor Castle, were published

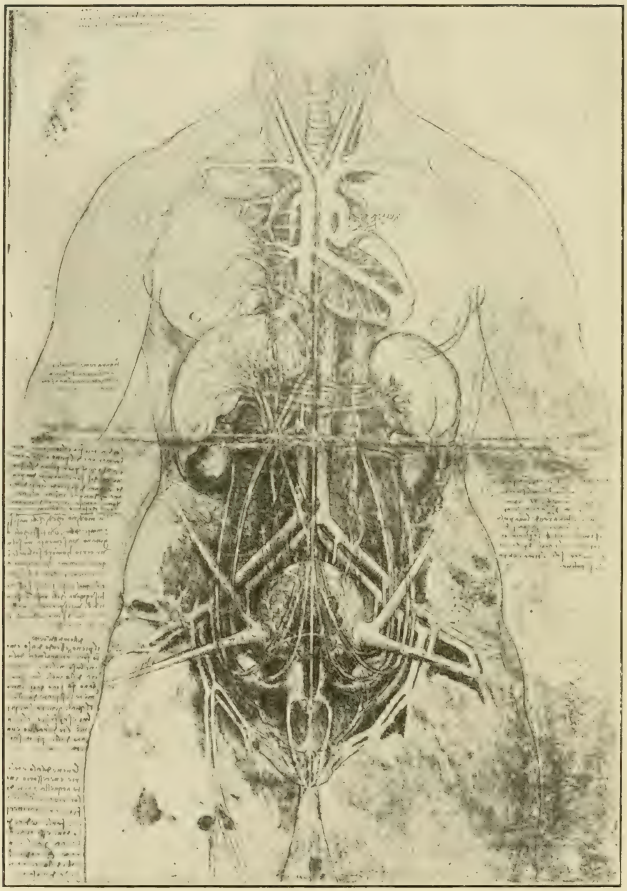

Fig. 15 Anatomical sketch by Leonardo da Vinci, 1510

in eight additional volumes in 1901. This does not include the volume on the anatomy of the horse. The range of the drawings is astonishing; the entire collection embraces more than 750 separate sketches, some of them being several times repeated. The notes accompanying the sketches, always written from right to left, are, usually, descriptions of the figures, but, sometimes, are general reflections regarding the plan of his projected book. That he read anatomy is evident since he specifically corrects some misstatements of Mundinus. Leonardo placed great reli-

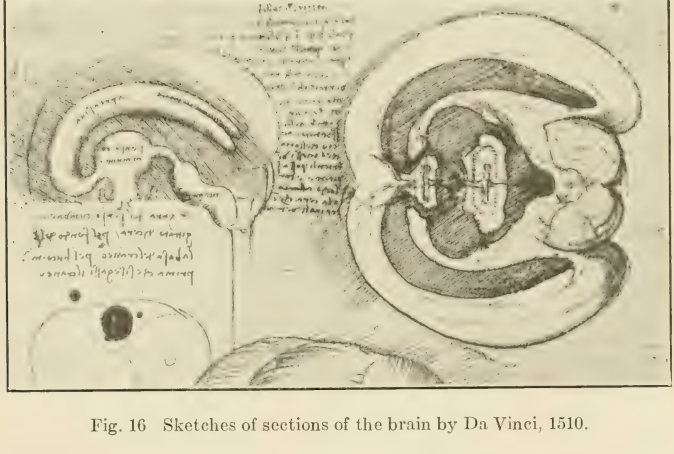

Fig. 16 Sketches of sections of the brain by Da Vinci, 1510.

ance on good figures, declaring them to be essential to the understanding of anatomy. Some of his delineations of muscles have been so frequently reproduced that they are well known, but it is not so generally known that he made deep dissections of all kinds including the viscera and the brain.

The reproduction of a few of Leonardo's sketches will serve to show their quality, and will at once reveal the fact that they are totally different from any other sketches of the period. These drawings are not made from anatomical descriptions, but from

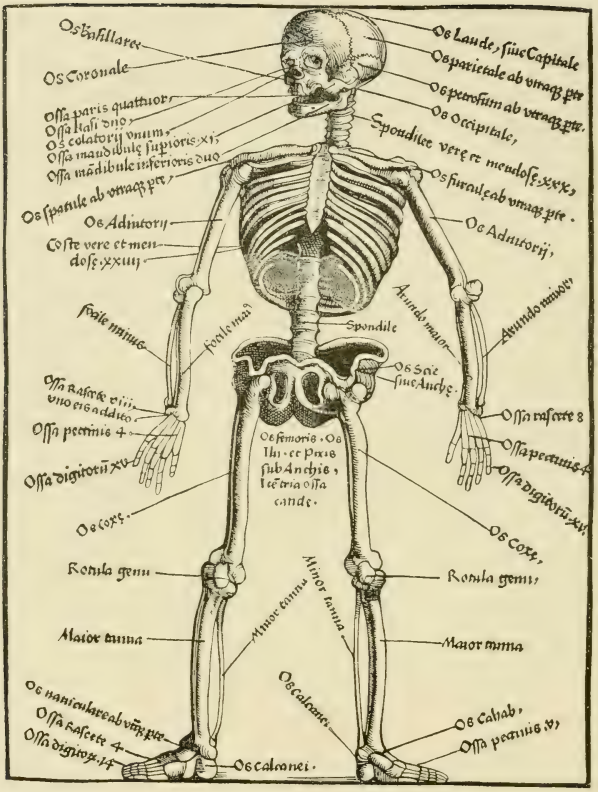

Fig. 17 Plate of the skeleton published by J. Schott, 1517 (after Wieger)

original observations. The drawings speak for themselves, accordingly brief comments will suffice.

Fig. 12 shows a page with four separate figures and manuscript notes. The heart and chief blood vessels of the thorax and abdomen, and the sketches of the lungs are obviously made from actual dissections of the human body.

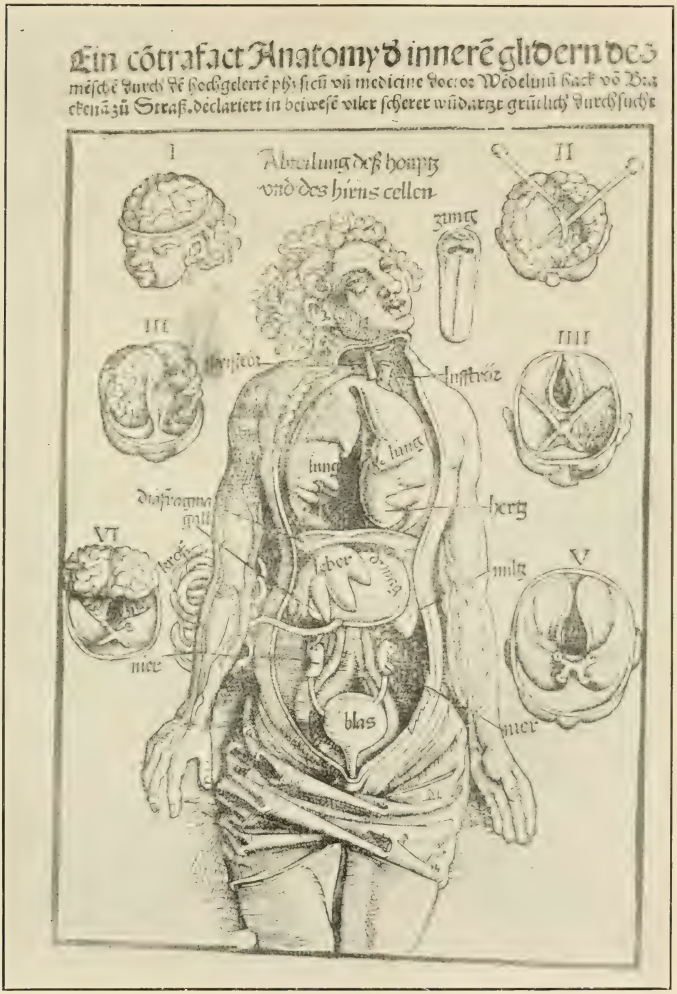

Fig. 18 Anatomical sketches from Phryesen's Spiegel der Artzney, 1517. This cut from a Dutch edition of 1519

Fig. 19 Title page of the Commentaries on Mundinus by Berengarius, 1521

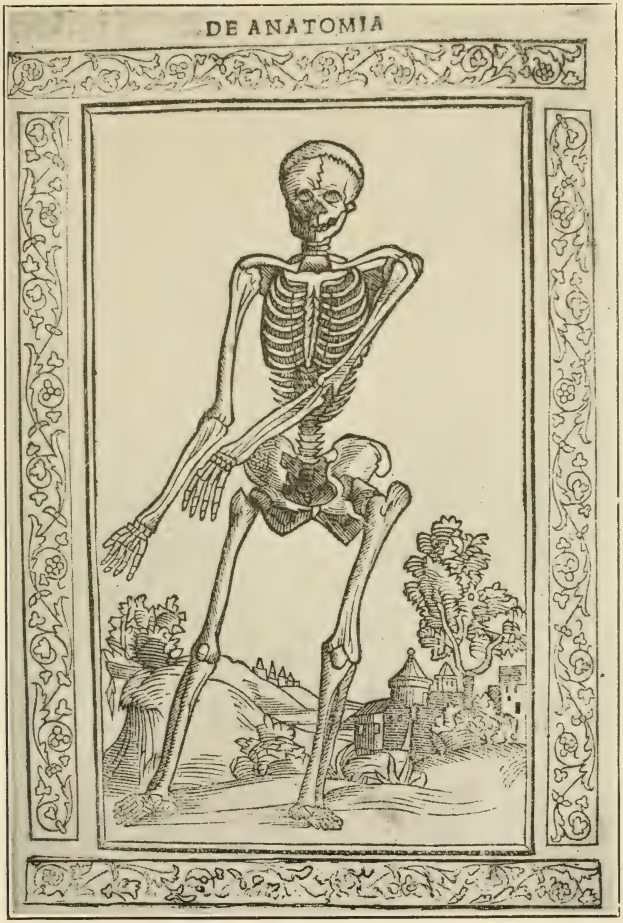

Fig. 20 Figure of the skeleton from the Isogogæ Breves of Berengarius, 1523

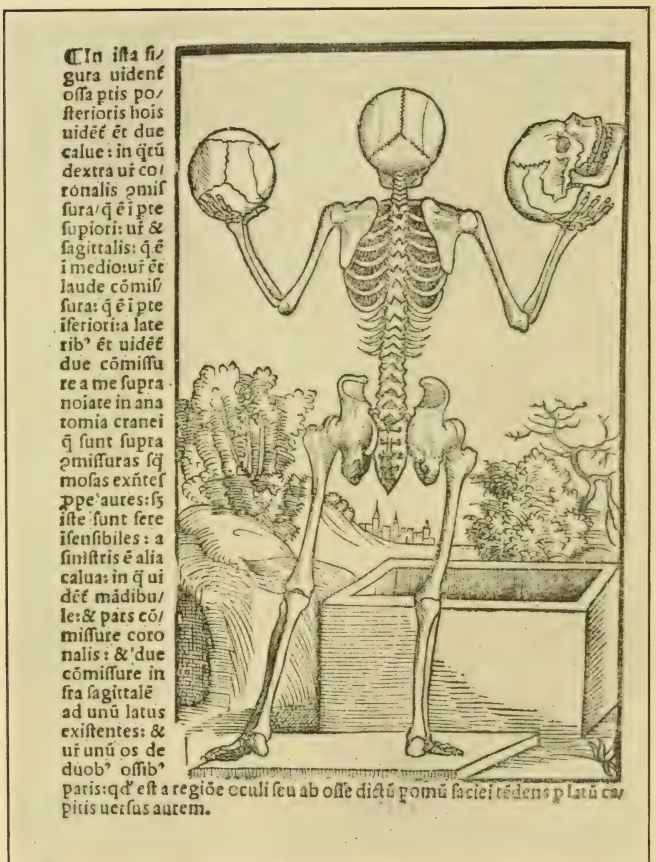

Fig. 21 Posterior view of the skeleton from the Commentaries on Mundinus of Berengarius, 1521

Fig 13 shows the chief blood vessels of the neck and the adjacent region.

Fig. 14 shows a deep dissection of the blood vessels of the thigh.

In fig. 15 we have a rather comprehensive dissection of the thorax and abdomen with the alimentary canal removed. The original of this figure is $13\frac{1}{2}$ x 22 inches.

A limited number of drawings can give no adequate conception of Leonardo's work in anatomy. His sketch of the stomach and intestine is a good drawing of the relative size and the normal arrangement of these viscera. In the delineation of muscles it is not merely the superficial layers that engage his attention, he shows details of the arrangement of the tendons on the toes and fingers, a number of cross-sections of the leg at different levels, the muscular architecture of the heart, etc. Among his many pictures of the bones, he correctly draws vertebræ from various aspects, and the bones of the fore-arm in pronation as well as in other positions. He made sketches of the dissection of nerves. His figures on generation show uteri opened, with contained foetuses, and the placental connection.

Before leaving his work, however, we should have one of his sketches of the brain as shown in fig. 16. Here one sees, on the left, a median sagittal section, and, on the right, a horizontal section. These sketches show fairly the extent to which the brain had been dissected up to the year 1510.

Other contemporary or nearly contemporary artists, as Michael Angelo, Raphael, and Albrecht Dürer, made anatomical sketches, but not so comprehensive as those of Da Vinci, and the details regarding which it is not necessary to consider.

Johannes Schott. In 1517 there appeared from the publishing house of John Schott at least two anatomical plates, one representing a skeleton and the other a sketch of the internal anatomy of the body. The picture of the skeleton is shown in fig. 17. It is still very crude in its execution, but in some particulars is an improvement on the earlier printed figures. The skull is better drawn than in the plates of Helain and Grüninger (figs. 3 and 4), but it still shows the spurious 'os laude, sive capitale.'

There are other marked deficiencies as in the arm and wrist, where the carpal bones are enumerated as eight, but are not drawn, etc., etc. The sketch of the internal dissection was published in several texts as in the Phryesen of 1518 (see Chievitz, p. 90), 1529, etc. Choulant reproduces a similar but not identical figure, also from Phryesen, the plate of which bears the date 1517.

Phryesen. (Fries, Friesen, etc.) In 1518 there appeared in Strassburg the Spiegel der Artzney of Laurentius Phryesen, containing two plates. The one is a copy of the Grüninger skeleton (see fig. 4), and the other a visceral anatomy, surrounded by six figures of the anatomy of the brain and one of the tongue. This cut appears in the different editions of Phryesen with some modifications. Fig. 18 shows a copy of this plate from a Dutch edition of Phryesen dated Strassburg, 1519. The original woodcut is $5\frac{1}{2}$ x $7\frac{5}{8}$ inches. The edition of 1529 contains another picture of the visceral dissection,—the same as shown in Chievitz, fig. 31,— that lacks the marginal sketches of the brain, and is also somewhat different in other details. The figures of the brain in the Spiegel der Artzney, except for those of Leonardo, are a new departure in anatomical illustrations.

Jacobus Berengarius Carpensis (Carpus). Berengarius has often been heralded as the greatest anatomist between Mundinus and Vesalius, and, if we except Da Vinci, the assignment of this rank to him is perhaps justified. Whatever may be said of his alleged dissection of more than one hundred bodies, the illustrations of Berengarius are not original, nor are they based on good observation. They bear resemblance to sketches in the manuscripts of the fourteenth century and to printed pictures in earlier publications, as the Conciliator differentiarum (1496), Margarita philosophica (1504), etc. As has already been said, we find that all sketches of the period, with the sole exception of those of Da Vinci, show interrelationships with manuscript illustrations as well as with earlier printed figures. As Roth has pointed out, the anatomical writings of Berengarius are compilations without credit being given to the original sources, and there is inharmony between his text and the illustrations,—a circumstance that is, at times, adverted to by himself. It is altogether likely that the

cuts were inserted by his publisher from such pictures as were available.

The first anatomical publication of Berengarius was an extensive series of commentaries on Mundinus. In this the text of Mundinus is printed in larger type, and the forty commentaries in smaller, but so extensive are the annotations that the book is brought up to a thick quarto volume of 1056 pages. This book, published at Bologna in 1521, is rare and a cut of the title page is shown in fig. 19. The size of the original is $4\frac{3}{4}$ x 7 inches; the border is red and the enclosed printing black. His commentaries contain at times corrections to Mundinus, and show the results of some observations mixed with dialectic compilations from the earlier writers. In the 21 illustrations the dependence on tradition is very marked.

He soon branched out for himself and wrote an introduction to anatomy, designated Isogogæ breves, etc., which was first published in 1522 and followed by a modified edition in 1523 which is the only one well known. In addition to a copy of his commentaries of 1521, I have had for examination three editions of the Isogogæ breves; that of 1523, Bologna, 4°, 80 leaves with 23 woodcuts; an edition of 1535, Venice, 4°, 63 leaves, 19 plates, and a small pocket edition ($2\frac{3}{8}$ x $4\frac{1}{4}$ inches letter-press), dated 1530, and containing 24 figures. The illustrations are wretched copies of those of the edition of 1523, the increase in their number, by one, is owing to the separation of two figures that appear on one plate in the larger edition. This appears to have been a relatively cheap edition for students.

More than one-half the illustrations of the commentaries are reproduced in the Isogogæ of 1523 and new ones are added. Most of the plates in the edition of 1523 are provided with an ornamental border, added to a double line boundary, while the plates of the commentaries of 1521, are limited by a single line border. Roth reproduces a full-size figure of the skeleton from the Isogogæ of 1523, but his plate lacks the ornamental border.

Fig. 20 is a representation of the skeleton from the Isogogæ of 1523 in which the ornamental border has been retained, but the marginal description, present in the original, has been cropped

off. This curious figure has 13 ribs, widely expanded pelvis and a spurious fissure in the frontal bone.

The posterior view of the skeleton, shown in fig. 21, is taken from the commentaries of 1521. It has a single-line border and the marginal note has been retained. The basin-like pelvis appears more fantastic than in the preceding figure. The skull shows two spurious furrows on the parietal bones, the presence of which seem to have confused Berengarius. The two best illustrations in Berengarius are those of the bones of the hand and of the foot. The close resemblance of these pictures to drawings of Leonardo da Vinci gives ground for the suspicion that they were in some way based upon his sketches. Although this is a mere conjecture, these two figures are on a different plane of accuracy from any other illustrations in the Isogogæ breves.

Dryander (also known as Johann Eichmann). This professor of anatomy at Marburg published, in 1537, an Anatomiae h. e. corporis humani dissectionis pars prior, etc., illustrated by 20 plates that were based on dissections. I have not seen a copy of this work, but have examined his edition of Mundinus and other earlier writers, published in 1541, which contains most of these earlier figures, some new ones, and 18 figures copied from Berengarius. The copy at my disposal contains 45 figures, one plate of which is repeated. Some of Dryander's illustrations are a considerable improvement on those of Berengarius. Fig. 22 shows his sketch of the alimentary tube, the original woodcut being $4\frac{1}{4}$ x 6 inches. The drawing of the caecum and the vermiform appendix shows that it is based on observation, but the figure is not so good as that of Da Vinci of the corresponding parts.

Walther Hermann Ryff. In 1541 appeared Ryff's Anatomi with a very long and cumbersome title. This book, of which I have examined a copy in Dutch and one in German, was published after the first plates of Vesalius (1538) and before the appearance of the famous Fabrica (1543). It, with the Dryander mentioned above, lies on the border line of pre-Vesalian illustrations of anatomy. One of Ryff's illustrations of the arterial circulation, reproduced in fig. 23, gives a fair idea of the appearance of his sketches.

Other anatomical illustrations of the pre-Vesalian period embrace the very rare copper plates of Canano, showing bones and muscles of the arm. Choulant says that, prior to 1543, one book

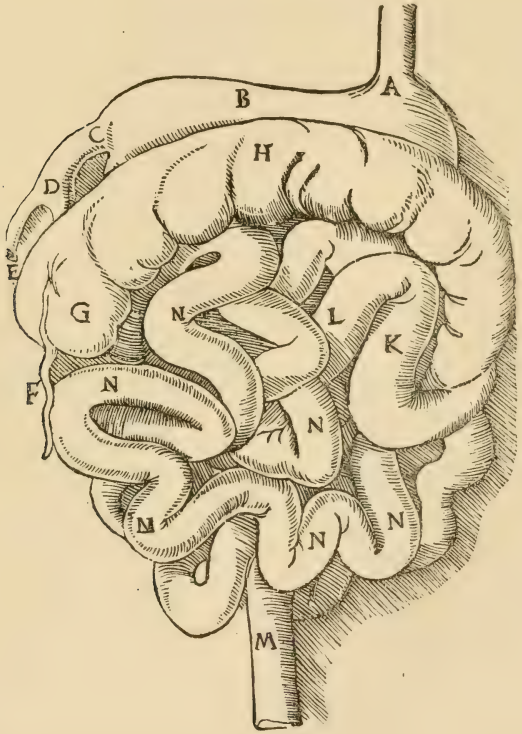

Fig. 22 Anatomical sketch from Dryander's edition of Mundinus, 1541

of the work was published, containing 27 illustrations, but the work was never completed. Between 1536 and 1543 there were several plates of anatomical figures placed on the market. These so-called 'Fliegende Blätter' include the six Tabulæ anatomicæ

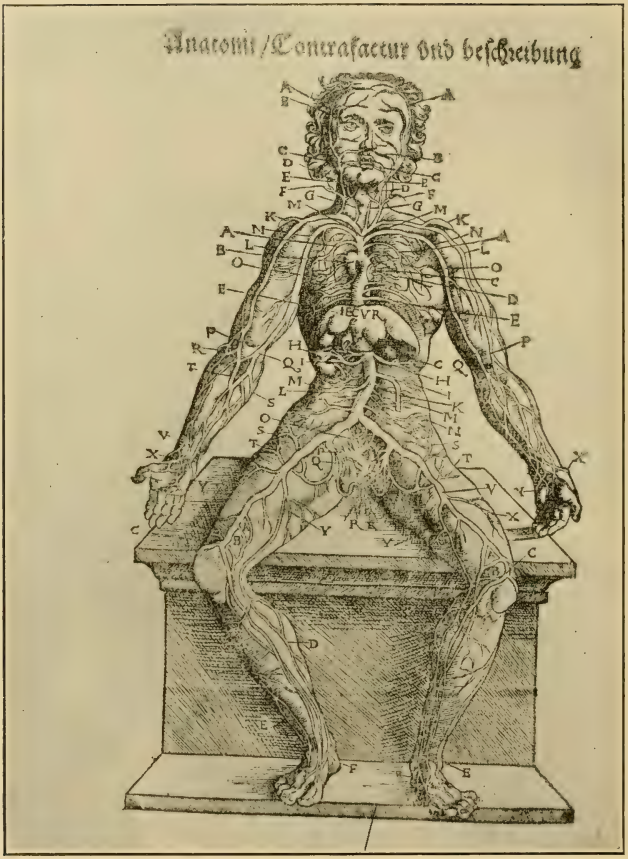

Fig. 23 Anatomical sketch from Ryff's Anatomi, 1541

of Vesalius that appeared in 1538 and were a forerunner of his great work of 1543.

There were also during the period other anatomists of more than usual insight, as Achillini, whose anatomical treatises were

not illustrated, and, therefore, do not properly come under consideration here.

Summary. The chief printed illustrations of anatomy before Vesalius may now be chronologically arranged, omitting different editions of the same work with slight modifications of the figures:

1491. The arrangement of the viscera in the human female in Ketham's Fasciculus Medicine.
1493. The skeleton of Richard Helain.
1493(?). A demonstration of visceral anatomy in the Melerstat edition of Mundinus.
1496. The abdominal muscles, in the Conciliator differentiarum.
1497. Plate of the Grüninger skeleton.
1497. The wounded man with internal anatomy in Brunschwig's Chirurgie.
1499. Anatomy of the three body cavities, together with figures of the separate organs, in Peyligk's Compendicsa.
1501. Similar illustrations in Hundt's Antropologium.
1503-'04. Organs of the thorax and abdomen in Reisch's Margarita Philosophica.
1510 (?). Leonardo da Vinci, more than 750 sketches of human anatomy; not, however, published.
1513. Mundinus, zodiacal signs and rough sketch of the heart.
1517. Plates of visceral anatomy and of the skeleton published by Johann Schott.
1518. Skeleton and visceral anatomy in Phryesen's Spiegel der Artzney.
1521, '22-'23. Berengarius, commentaries on Mundinus and Isogogæ breves.
1536. Fliegende Blätter.
1538. Six Tabulæ Anatomicæ of Vesalius.
1537. Dryander, Anatomiae, corporis humani, etc.
1541. Dryander, edition of Mundinus, with 45 illustrations.
1541. Ryff, Anatomi.

The survey of these printed sketches of anatomy, covering a century-and-a-half before Vesalius, brings into notice the relatively slow progress. While we remember that this is the period of the awakening of the scientific spirit, still, the drama of intellectual progress does not unfold as rapidly as we might expect. Why, after the revival of dissection under Mundinus, and why, especially, after the introduction of printing, was there not more rapid progress? Some seek to find an answer in the difficulty of getting material for dissection and others in the opposition of the church, but the thing that held anatomical science in check, was not so much the lack of opportunity to dissect as the mental habit of the time. The disposition to dissect was not especially strong. That internal hunger for the analysis of nature at first-hand was not of dominating insistence. The effects of tradition and of education had to be overcome, and the gradual assimilation of new methods and new ideas was necessarily slow. Those who would have done better under gifted and inspired leaders were perplexed and too closely bound by the mental habit of the time to map out and follow an independent course. Thus, the retarding influence was generic rather than specific. Independent spirits of great originality were rare then, as now, and it seems natural that the habit of imitation should have so long perpetuated anatomical sketches of poor quality. Da Vinci was the only man whose product exhibits great originality and independence. His anatomical work was on the plane of that of Vesalius but his sketches were not printed until long after.

The practice of dissection by medical men was not so actively opposed by the church as is generally supposed. A superficial reading of the bull of Pope Boniface, *de Sepultis*, issued in 1300, has led to the statement that it was directed against the practice of dissecting for scientific purposes, but it was, in reality, a proscription of the practice of dismembering the bodies of dead Crusaders, in order that their bones might be more readily transported home for burial in consecrated ground.

The practice of plagiarism was widespread during this period. Publishers and authors engaged in it in a wholesale way; both sketches and text were commonly copied without credit being

given. The ethics of the rights of intellectual property were unrecognized. The earliest printed sketches were derived from manuscript sources and, these, in turn, were based upon the traditional anatomy, chiefly of Galen and his commentators. Now and then a touch of original observation was added to the traditional figures but they were not perfected. Dependence on authority was still the deep-seated method of the intellectual life, and the rise of independent observation was slow. But, the better intellects were opposing it, and with all these limitations the light of the renaissance was breaking. Dependence on authority was giving way, and, finally, thanks to the work of his predecessors, Vesalius was able to establish a new method based on observation and reason. With the publication of his Fabrica in 1543, there was ushered in the era of good illustrations of anatomy. The prevailing mental habit of the time was now at least partly overcome and the era of independent observation was started.

BIBLIOGRAPHY

The full titles of the printed books from 1491 to 1543, containing anatomical cuts, and listed in the body of this paper as 'Sources,' are often long and cumbersome. They will be found in the Catalogue of the Surgeon General's Library, in the lists of printed books in The British Museum, in Hain's Repetorium Bibliographicum, in Haller's Bibliotheca Anatomica, etc. The other books used chiefly as references are:

Ball 1911 Andreas Vesalius the Reformer of Anatomy.

Baas 1889 Outlines of the history of medicine. New York.

Chievitz 1904 Anatomiens historie. Copenhagen.

Choulant 1852 Geschichte der anatomischen Abbildungen. Leipzig.

Hopf 1904 Die Anfange der Anatomie bei den alten Kulturvölkern, in Abhandl. zur Ges. der Medizin. Breslau.

Pagel 1898 Geschichte der Medizin. Berlin.

Puschmann 1902–05 Handbuch der Geschichte der Medizin. Jena.

Roth 1892 Andreas Vesalius Bruxellensis. Berlin.

Sudhoff 1907–08 Various articles in Studien zur Geschichte der Medizin, Leipzig; and in Archiv für Geschichte der Medizin. Leipzig.

Töply 1903 Geschichte der Medizin, in Puschmann's Handbuch. Jena.

Weindler 1908 Geschichte der gynäkologisch-anatomichen Abbildung. Dresden.

Wieger 1885 Geschichte der Medizin und ihrer Lehranstalten in Strassburg vom Jahre 1497 bis zum Jahre 1872. Strassburg.